भारतीय मानक
Indian Standard

IS 10804 (Part 2) : 2018

कृषि प्रयोजनों के लिए अनुशंसित पम्पिंग प्रणालियाँ

भाग 2 सब्मर्सिबल पम्प सेट्स

(तीसरा पुनरीक्षण)

Recommended Pumping Systems for Agricultural Purposes

Part 2 Submersible Pump Sets

(Third Revision)

ICS 23.100.10.65

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Pump Sectional Committee, MED 20

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Pumps Sectional Committee had been approved by the Mechanical Engineering Divisional Council (MEDC).

Indian Standard Recommended Pumping Systems for Agricultural Purposes was first published in 1984 and revised in 1986 and 1994. In this third revision, the Standard has been split in two parts. Part 2 is for the Submersible Pump sets. The other part in this series is IS 10804 (Part 1) Surface Pumps. Standard has been revised to enable the users to select the most efficient pumping system for his requirement taking into account the practical aspects of agricultural pumping. Accordingly, the examples and graphs have been modified.

Further, it was necessary to ensure that selected system is an efficient one, the pump / pump set efficiency values has been included for various total heads and flow rates in the form of minimum charts of IS 8034 and IS 14220.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the results of a test or analysis, shall be rounded off in accordance with IS 2:1960‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

RECOMMENDED PUMPING SYSTEMS FOR AGRICULTURAL PURPOSES

PART 2 SUBMERSIBLE PUMP SETS

(Third Revision)

1 SCOPE

This Standard covers the recommended pumping system for submersible pump-sets used for agricultural purpose and its necessary accessories such as pipes, pipe fittings, safety and protection devices (electrical & mechanical).

2 REFERENCES

The standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Annex A.

3 RECOMMENDED PUMPING SYSTEM

Different components of pumping system shall conform to the following Indian standards besides matching with other components:

Sl No.	*Component*	*Indian Standards*	*Criteria*
(1)	(2)	(3)	(4)
1.	Submersible pump sets Open well submersible pump sets	IS 8034 IS 14220	The pump shall be selected in such a way that it shall operate at near maximum pump efficiency during peak demand period in the specified range of discharge and head. It should also be capable of giving required discharge in summer season.
2.	Piping system	IS 1239 (Part 1) IS 4984 IS 4985 IS 12231 IS 1239 (Part 2) IS 10124 (Part 8) IS 13593	The size of pipes shall be selected in such a way that the friction head (h_f) shall not exceed 10 percent for the total equivalent length of piping system up to delivery point. The data given in Fig. and Tables shall be used to determine approximate sizes of pipes. If the delivery distance is more than 3 m, then larger pipe sizes shall be used to reduce the friction losses.
3.	Bore valve and reflex valve	IS 10805	Size of valve shall be equal or greater than the size of the discharge pipe.
4.	Pipe fittings	IS 1239 (Part 2) IS 10124 (Part 3) IS 13593	The size of bends and other fittings shall be matching with the size of the GI pipes, HDPE pipes or RPVC pipes to be used in piping system.
5.	Code of Practice	IS 14536	This standard lays down general guidelines for selection, installation, operation and maintenance of bore-well submersible pump-sets covered in IS 8034.

4 TERMINOLOGY

4.1 Bore-well and Bore-well Size

4.1.1 Bore-well is avery deep narrow whole in the ground made in order to water.

4.1.2 The bore-well should be straight in relation to the pump-set, the bore-well should be tested throughout its depth with a pattern with overall length and diameter equal to the maximum dimensions of the pumpset.

4.2 Openwell — It covers ordinary open wells of varying dimension dug or sunk from the ground surface into water bearing stratum to extract water for irrigation purposes. These are broadly masonry wells and dug-cum bore-wells and all such schemes are of private nature belonging to individual cultivators.

4.3 Static Water Depth— It is the depth of water level below the ground level when the pump is not in operation.

4.4 Draw-Down — It is the difference between the depth of static water level and the consistent standing water level in the tube well or rock well during pumping operation.This will happen when flow rate of pumpset is less than yield of the bore-well.

4.5 Draw-Down Level — It is depth of consistent standing water level below the ground level in the tube well or rock well during pumping operation.

4.6 Submergence — It is the minimum height of water level after draw-down above the pump suction casing/suction inlet, while running.

4.7 Characteristics of Clear, Cold Water

Clear, cold water shall mean water having the characteristics specified below:

Turbidity : 50 ppm, *Max* (silica scale)
Chlorides : 500 ppm, *Max*
Total solids : 3000 ppm, *Max*
*p*H : 6.5 to 8.5
Temperature : 33°CMax
Specific gravity : 1.004, *Max*
Hardness : 300, *Max* (drinking water)

NOTE — If the characteristics of water differ from these specifications, the pump constructional details shall be agreed between the manufacturer/supplier and the user. In such cases, the characteristics shall be specified in the order.

5 YIELD TESTING

Yield testing is the process to estimate the yield of a bore-well and it is recommended to perform yield testing for a new bore-well. This test will assist in selection of a suitable capacity pump (lower capacity pump set) without over-pumping of the bore-well. This test shows the balance between amount of water that can be pumped out of the bore-well and the amount of water that recharges back into the bore-well from the surrounding groundwater source. This test requires continuous pumping of the bore-well for an extended period of time. During the pumping period, measurements are made to find out the rate at which the water is being pumped out of the bore-well and the depth to which the water level is lowered in the well as a result of pumping, this is known as draw down level. *See* Fig 8 for the bore-well yield testing using test pumpset.

6 ESTIMATION OF FLOW RATE AND CALCULATION OF TOTAL HEAD FOR IRRIGATION

6.1 Estimation of Flow Rate for Irrigation — The estimated flow rate for irrigation shall be selected from Table 1, 2 and 3.

6.1.1 The flow rate (discharge rate) 'Q' of water required shall be determined as per the guidelines given in IS 9694 (Part 1). In case, yield is less, operating hours of the pump set shall be increased to match the yield.

6.2 Calculation of Total Head for Irrigation

6.2.1 *Total Static Head* (h_{st})

It shall be calculated by adding static water depth (h_{ss}), draw down and static delivery head (h_{sd}) (vertical height from ground level to the final delivery point).

6.2.2 *Pipe Frictional Head Losses*

Pipe frictional losses are pressurehead losses which occur during the water flow in any kind of conduit pipe.

The friction losses in the piping system depends on the following factors:

a) Pipe inner diameter;
b) Material and inner surface roughness of pipe,
c) Length of pipe line; and
d) Number of bends, elbows, valves and other pipe fittings.

Based on the flow rate of water required and material of pipe, delivery pipe size shall be selected from Table 4, 5, 6 and 7 to limit the maximum friction losses in pipes to below 10 percent of the pipe length.

In case, water is to be delivered to a long distance, friction losses in delivery pipe may have to be limited to much lower value (may be as low as 0.5 to 1 percent depending on the length) in orderto limit the total head and thereby limit the prime mover rating and finally energy charges. Thus in such cases, larger size delivery pipes may be selected depending on cost economics.

6.2.3 The length of piping required shall be determined from the actual delivery pipe length from pump set to delivery point and length of straight pipe giving equivalent friction head loss in pipe fittings, valves as per Table 11 (also *see* Fig.8).

6.2.4 The friction losses in the pipes shall be computed for the pipe length worked out as per clause **6.2.3** based on flow rate (Q) and pipe size (*see* tables 8, 9 and 10 or figure 2 and figure 3)

6.2.5 Velocity head losses ($Vd^2/2g$) shall be worked out based on tables8, 9 and 10.

6.2.6 Total head (H) shall be calculated by adding static head (h_{st}) (draw down level elevation height upto delivery point), friction losses in pipes and pipe fittings (h_{fs})and discharge velocity head ($Vd^2/2g$).

$$H = h_{st} + h_{fs} + \text{Discharge velocity head}$$

6.3 Protection Device for Pump — Non Return Valve — Use of Non return valve is recommended for every 60 m of delivery column pipe above the pump inbuilt non return valve inside the bore-well. Also use of a non-return valve is recommended at the bore-well and openwell ground level if the delivery pipe is directly connected to long distance piping system to prevent the effects of water hammer on the pump set parts.

7 SELECTION OF PUMPING SYSTEM

7.1 The pump set and pumping system shall be selected with due reference to Tables 1, 2 and 3 and / or the field requirements. The type of pump set shall be openwell or bore-well submersible as required.

7.2 Select suitable pipe material and pipe size for column pipe, delivery pipe as explained in clause **6.2**.

7.3 Calculate total head as explained in clause **6.2**.

7.4 Choose the type of pump set to be used. i.e. a bore-well pump or open well pump according to the well type.

7.5 Select suitable pump based on calculated head and flow rate. Pump shall be selected such that the operating point lies close to the best efficiency point (BEP) on the pump characteristics curve as computed in clause **6.2**.

Table 1 Irrigation Requirements of Some Crops in Hard Rock Areas IS 9694 (Part 1)

Sl No.	Crop	Cropping Period in Days	Depth of Watering in mm	Watering Interval in Days		* Irrigation requirements in mm
				Summer	Winter	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Rice	100 to 160	75	7	–	800 to 1600
ii)	Wheat	90 to 100	75	–	10 to 15	300 to 450
iii)	Maize	100 to 120	50	7 to 10	–	150 to 300
iv)	Gram	150 to 180	75	–	15 to 20	150 to 300
v)	Sugarcane	360 to 540	120	7 to 10	15 to 20	100 to 2100

NOTE — Sugarcane can be either a 12months crop or a 18months crop known as Adhsali.

*The values given are for reference purposes only.

Table 2 Irrigation Requirements of Some Crops in Alluvial Areas IS 9694 (Part 1)

Sl No.	Crop	Cropping Period in Days	Depth of Watering In mm	Watering Interval in Days		* Irrigation requirements in mm
				Summer	Winter	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Rice	100 to 160	75	7	–	800 to 1600
ii)	Wheat	120 to 160	75	–	10 to 15	300 to 400
iii)	Maize	100 to 120	50	7 to 10	–	150 to 300
iv)	Gram	150 to 180	50	–	15 to 20	100 to 150
v)	Sugarcane	300 to 360	75	7 to 10	15 to 20	600 to 800

*The values given are for reference purposes only.

Table 3 Area Irrigated in Hectares in 8 Hours Pumping IS 9694 (Part 1)

Sl No.	Volume Rate of Flow in l/s	Depth of Water in mm					
		25	50	75	100	125	150
(1)	(2)	(3)	(4)	(5)	(5)	(7)	(8)
i)	0.50	0.058	0.029	0.019	0.014	0.011	0.010
ii)	1.00	0.115	0.058	0.038	0.029	0.023	0.019
iii)	1.25	0.144	0.072	0.048	0.036	0.029	0.024
iv)	1.60	0.184	0.092	0.061	0.046	0.037	0.031
v)	2.00	0.230	0.115	0.077	0.058	0.046	0.038
vi)	2.50	0.288	0.144	0.096	0.072	0.058	0.048
vii)	3.2	0.369	0.184	0.123	0.092	0.074	0.061
viii)	4.0	0.461	0.230	0.154	0.115	0.092	0.077
ix)	5.0	0.576	0.288	0.192	0.144	0.115	0.096
x)	8.0	0.922	0.461	0.307	0.230	0.184	0.154
xi)	10.0	1.152	0.576	0.384	0.288	0.230	0.192
xii)	12.5	1.440	0.720	0.480	0.360	0.288	0.240
xiii)	16	1.843	0.922	0.614	0.461	0.369	0.307
xiv)	20	2.304	1.152	0.768	0.576	0.461	0.384
xv)	25	2.880	1.440	0.960	0.720	0.576	0.480
xvi)	32	3.686	1.843	1.229	1.922	0.737	0.614
xvii)	40	4.608	2.304	1.536	1.152	0.922	0.768
xviii)	50	5.760	2.880	1.920	1.440	1.152	0.960
xix)	65	7.488	3.744	2.496	1.872	1.498	1.248
xx)	80	9.216	4.608	3.072	2.304	1.843	1.536
xxi)	100	11.520	5.760	3.840	2.880	2.304	1.920
xxii)	125	14.400	7.200	4.800	3.600	2.880	2.400

Table 4 Permissible Ranges of Volume Rates of Flow in l/s Through Galvanized Steel Pipes to Limit Friction Losses to 10 Percent of the Pipe Length (IS 1239, C = 140)

Sl No.	Nominal Outside Dia mm	Pipe Grade		
		Light Rate of Flow l/s	Medium Rate of Flow l/s	Heavy Rate of Flow l/s
(1)	(2)	(3)	(4)	(5)
i)	40	1.90 – 2.74	1.79 – 2.67	1.59 – 2.41
ii)	50	2.74 – 5.24	2.67 – 4.95	2.41 – 4.54
iii)	65	5.24 – 9.97	4.95 – 9.80	4.54 – 9.17
iv)	80	9.97 – 15.54	9.80 – 14.97	9.17 – 14.20
v)	100	15.54 – 30.84	14.97 – 30.00	14.20 – 28.67
vi)	125	–	30.00 – 52.50	28.67 – 51.37
vii)	150	–	52.50 – 84.18	51.37 – 82.63

Table 5 Permissible Ranges of Volume Rates of Flow in l/s Through RPVC Pipes to Limit Friction Losses to 10 Percent of the Pipe Length (IS 4985, C = 150)

Sl No.	Nominal Outside Dia	Pipe Grade		
		Class 2 (0.25 MPa) Rate of Flow l/s	Class 3 (0.4 MPa) Rate of Flow l/s	Class 4 (0.6 MPa) Rate of Flow l/s
(1)	(2)	(3)	(4)	(5)
i)	40	–	–	Up to 2.04
ii)	50	–	–	2.04 – 3.70
iii)	63	–	3.80 – 7.24	3.70 – 6.77
iv)	75	–	7.24 – 11.47	6.77 – 10.76
v)	90	11.50 – 19.58	11.47 – 18.59	10.76 – 17.41
vi)	110	19.58 – 33.25	18.59 – 31.71	17.41 – 29.75
vii)	125	33.25 – 46.63	31.71– 44.33	29.75 – 41.44
vii)	140	46.63 – 62.92	44.33 – 59.79	41.44 – 55.97
ix)	160	62.92 – 89.28	59.79 – 84.95	55.97 – 79.76

Table 6 Permissible Ranges of Volume Rates of Flow in l/s through HDPE Pipes to Limit Friction Losses to 10 Percent of the Pipe Length (IS 4984, C = 150)

Sl No.	Nominal Outside Dia mm	Pipe Grade		
		Class 2 (0.25 MPa) Rate of Flow l/s	Class 3 (0.4 MPa) Rate of Flow l/s	Class 4 (0.6 MPa) Rate of Flow l/s
(1)	(2)	(3)	(4)	(5)
i)	40	–	Up to 1.87	Up to 1.62
ii)	50	–	1.87 – 3.40	1.62 – 2.92
iii)	63	3.40 – 6.92	3.40 – 6.29	2.92 – 5.40
iv)	75	6.92 – 11.01	6.29 – 9.86	5.40 – 8.59
v)	90	11.01 – 17.80	9.86 – 15.96	8.59 – 13.86
vi)	110	17.80 – 30.21	15.96 – 27.65	13.86 – 23.60
vii)	125	30.21 – 42.30	27.65 – 38.23	23.60 – 33.00
viii)	140	42.30 – 57.11	38.23 – 51.33	33.00 – 44.63
ix)	160	57.11 – 81.33	51.33 – 72.89	44.63 – 63.41

Table 7 Permissible Ranges of Volume Rates of Flow in l/s ThroughRPVC Pipes to LimitFriction Losses to 10 Percent of the Pipe Length(IS 12231, C = 150)

Sl No.	**Nominal Outside Dia** Mm	**Pipe Grade** **Type 1 W (0.4 MPa) Rate of Flow** l/s	**Type 2 W (0.6 MPa) Rate of Flow** l/s
(1)	(2)	(3)	(4)
i)	63	3.40 – 6.29	2.92 – 5.40
ii)	75	6.29 – 9.86	5.40 – 8.59
iii)	90	9.86 – 15.96	8.59 – 13.86
iv)	110	15.96 – 27.65	13.86 – 23.60
v)	140	27.65 – 51.33	23.60 – 44.63

Table 8 Frictional losses in metres per 100 metre pipe length and velocity head in metres for New G.I.Pipe of medium series

Sl No.	**Nominal Pipe Size in mm Inside Dia mm**	**50**		**65**		**80**		**100**		**125**		**150**	
		52.95		**68.65**		**80.65**		**105.05**		**129.95**		**155.5**	
(1)	(2)	(3)		(4)		(5)		(6)		(7)		(8)	
	Discharge LPS	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.
i)	2	1.87	0.04										
ii)	3	3.95	0.09										
iii)	4	6.73	0.17										
iv)	5	10.18	0.26										
v)	6			4.03	0.13								
vi)	7			5.36	0.18								
vii)	8			6.86	0.24								
viii)	9			8.54	0.30								
ix)	10			10.38	0.37								
x)	11					5.65	0.24						
xi)	12					6.64	0.28						
xii)	13					7.70	0.33						
xiii)	14					8.83	0.38						
xiv)	15					10.03	0.44						
xv)	16							3.12	0.17				
xvi)	20							4.72	0.27				
xvii)	24							6.61	0.39				
xviii)	28							8.80	0.53				
xix)	32							11.27	0.69	4.00	0.30		
xx)	36									4.97	0.38		
xxi)	40									6.05	0.46		
xxii)	44									7.21	0.56		
xxiii)	48									8.47	0.67		
xxiv)	52									9.83	0.78		
xxv)	55									10.90	0.88	4.55	0.43
xxvi)	60											5.34	0.51
xxvii)	65											6.20	0.60
xxviii)	70											7.11	0.69
xxix)	75											8.08	0.79
xxx)	80											9.11	0.90
xxi)	85											10.19	1.02

Table 9 Frictional losses in metres per 100 metre pipe length and velocity head in metres for RPVC Pipe of Class 3

Sl No.	**Nominal Pipe Size in** mm	**40**		**63**		**75**		**90**		**110**		**125**		**140**		**160**	
	Inside Dia mm	**36.8**		**58.1**		**69.3**		**83.2**		**102**		**115.7**		**129.7**		**148.4**	
(1)	(2)	(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)	
	Discharge LPS	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.
i)	1	2.68	0.05														
ii)	2	9.66	0.18														
iii)	3			3.77	0.12												
iv)	4			5.70	0.18												
v)	5			7.99	0.26												
vi)	6			10.63	0.36												
vii)	7					5.77	0.23										
viii)	8					7.18	0.29										
ix)	9					8.72	0.36										
x)	10					10.41	0.43										
xi)	11							5.02	0.25								
xii)	12							6.68	0.34								
xiii)	14							8.55	0.44								
xiv)	16							10.64	0.56								
xv)	18									4.79	0.31						
xvi)	20									5.72	0.37						
xvii)	22									6.72	0.44						
xviii)	24									7.79	0.52						
xix)	26									8.94	0.60						
xx)	28									10.16	0.69						
xxi)	30											6.20	0.47				
xxii)	32											6.93	0.53				
xxiii)	34											7.71	0.60				
xxiv)	36											8.52	0.67				
xxv)	38											9.37	0.74				
xxvi)	40											10.25	0.81				
xxvii)	42													5.88	0.52		
xxviii)	44													6.41	0.57		
xxix)	48													7.53	0.67		
xxx)	52													8.73	0.79		
xxxi)	56													10.01	0.92		
xxxii)	60															5.91	0.61
xxxiii)	64															6.66	0.70
xxxiv)	68															7.45	0.79
xxxv)	72															8.28	0.88
xxxvi)	76															9.15	0.98
xxxvii)	80															10.06	1.09

Table 10 Frictional losses in metres per 100 metre pipe length and velocity head in metre for HDPE Pipe of Class PN 4

Sl No.	Nominal Pipe Size in mm	50		63		75		90		110		125		140		150	
	Inside Dia mm	44.7		56.5		67.1		80.5		99.2		112.2		125.5		143.4	
(1)	(2)	(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)	
	Discharge LPS	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.	F.L.	V.H.
i)	1	1.04	0.02														
ii)	2	3.75	0.08														
iii)	3	7.94	0.19														
iv)	4	13.5	0.33	4.32	0.13												
v)	5			6.53	0.20												
vi)	6			9.16	0.29												
vii)	7			12.18	0.40	5.27	0.20										
viii)	8					6.75	0.26										
ix)	9					8.40	0.33										
x)	10					10.21	0.41										
xi)	11							5.02	0.24								
xii)	12							5.89	0.28								
xiii)	13							6.84	0.33								
xiv)	14							7.84	0.39								
xv)	16							8.91	0.44								
xvi)	18							10.04	0.50								
xvii)	20									4.52	0.28						
xviii)	22									5.49	0.34						
xix)	24									6.55	0.41						
xx)	26									7.69	0.49						
xxi)	28									8.92	0.58						
xxii)	30									10.24	0.67						
xxiii)	32											6.39	0.47				
xxiv)	34											7.20	0.53				
xxv)	36											8.05	0.60				
xxvi)	38											8.95	0.68				
xxvii)	40											9.89	0.75				
xxviii)	42											10.88	0.83				
xxix)	44													6.90	0.59		
xxx)	46													7.52	0.64		
xxxi)	48													8.17	0.70		
xxxii)	50													8.84	0.77		
xxxiii)	52													9.53	0.83		
xxxiv)	56													10.25	0.90		
xxxv)	60															6.14	0.61
xxxvi)	64															6.98	0.70
xxxvii)	68															7.86	0.80
xxxviii)	72															8.80	0.90
xxxix)	76															9.78	1.01
xxxx)	80															10.81	1.13

Table 11 Length of Straight Pipe in metres giving Equivalent Head Lossin Pipe Fittings, Valves, etc.

Sl No.	Size of Pipe In mm	Standard Elbow	Medium Elbow	Long Radius Elbow	45 Degree Elbow	Tee	Sluice/ Gate Valve Full Open	Globe Valve Full Open	Angle Valve Open	Foot Valve or Reflux Valve
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	25	0.82	0.70	0.52	0.40	1.77	0.18	8.24	4.57	2.04
ii)	40	1.31	1.10	0.85	0.61	2.74	0.29	13.4	6.71	3.05
iii)	50	1.67	1.40	1.07	0.76	3.35	0.37	17.4	8.54	3.96
iv)	65	1.98	1.65	1.28	0.92	4.26	0.42	20.1	10.0	5.18
v)	80	2.47	2.00	1.55	1.15	5.18	0.52	25.9	12.8	6.10
vi)	100	3.35	2.77	2.13	1.53	6.71	0.70	33.5	17.7	8.23
vii)	125	4.26	3.66	2.78	1.86	8.24	0.88	42.6	21.2	10.0
viii)	150	4.87	4.26	3.35	2.35	10.0	1.07	48.7	25.3	12.2
ix)	200	6.40	5.48	4.26	3.05	13.1	1.37	67.1	33.5	16.2
x)	250	7.62	6.71	5.18	3.86	17.1	1.74	88.5	42.6	20.4
xi)	300	9.75	7.92	6.10	4.57	20.1	2.04	100.5	51.8	24.4

Table 12 Dimensions of Unplasticized PVC Pipes (IS 12231)
All dimensions in millimeters

Sl No.	Nominal Outside Diameter (Nominal Size)	Mean Outside Diameter		Wall Thickness					
				Type 1 W (0.4 MPa)			Type 2 W (0.6 MPa)		
				Average Values	Individual Values		Average Values	Individual Values	
		Min	max	max	min	max	max	min	max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	63	63	63.3	1.9	1.5	1.9	2.7	2.2	2.7
ii)	75	75	75.3	2.2	1.8	2.2	3.1	2.6	3.1
iii)	90	90	90.3	2.6	2.1	2.6	3.7	3.1	3.7
iv)	100	110	110.4	3.0	2.5	3.0	4.3	3.7	4.3
vi	140	140	140.5	3.8	3.2	3.8	5.5	4.8	5.5

NOTES—

1 The table is based on metric series of pipe dimensions given in ISO 161/1 in respect of pipe dimensions.

2The wall thickness of pipes is based on a safe working stress of 8.6 MPa at 27°C and the working pressure gets reduced at sustained higher temperature. Occasional rise in temperature as in summer season with concurrent corresponding reduction in temperature during night has no deleterious effect on the life and working pressure of the pipes considering the total life of pipes.

Table 13 Dimensions of Unplasticised PVC Pipes(IS 4985)

All dimensions in millimetres.

Sl No.	Nominal Outside Diameter (Nominal Size)	Mean Outside Diameter		Outside Diameter At Any Point		Wall Thickness																	
						Class 1 0.25 MPa			Class 2 0.40 MPa			Class 3 0.60 MPa			Class 4 0.80 MPa			Class 5 1.00 MPa			Class 6 1.25 MPa		
		min	max	Min	max	Avg Max	min	max	Avg Max	min	max	Avg Max	min	max	Avg Max	min	max	Avg Max	min	max	Avg Max	min	max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
i)	20	20.0	20.3	19.5	20.5													1.5	1.1	1.5	1.8	1.4	1.8
ii)	25	25.0	25.3	24.5	25.5										1.6	1.2	1.6	1.8	1.4	1.8	2.1	1.7	2.1
iii)	32	32.0	32.3	31.5	32.5										1.9	1.5	1.9	2.2	1.8	2.2	2.7	2.2	2.7
iv)	40	40.0	40.3	39.5	40.5							1.8	1.4	1.8	2.2	1.8	2.2	2.7	2.2	2.7	3.3	2.8	3.3
v)	50	50.0	50.3	49.4	50.6							2.1	1.7	2.1	2.8	2.3	2.8	3.3	2.8	3.3	4.0	3.4	4.0
vi)	63	63.0	63.3	62.2	63.8				1.9	1.5	1.9	2.7	2.2	2.7	3.3	2.8	3.3	4.1	3.5	4.1	5.0	4.3	5.0
vii)	75	75.0	75.3	74.1	75.9				2.2	1.8	2.2	3.1	2.6	3.1	4.0	3.4	4.0	4.9	4.2	4.9	5.9	5.1	5.9
viii)	90	90.0	90.3	88.9	91.1	1.7	1.3	1.7	2.6	2.1	2.6	3.7	3.1	3.7	4.6	4.0	4.6	5.7	5.0	5.7	7.0	6.1	7.1
ix)	110	110.0	110.4	108.6	111.4	2.0	16	2.0	3.0	2.5	3.0	4.3	3.7	4.3	5.6	4.9	5.6	7.0	6.1	7.1	8.5	7.5	8.7
x)	125	125.0	125.4	123.5	126.5	2.2	1.8	2.2	3.4	2.9	3.4	5.0	4.3	5.0	6.4	5.6	6.4	7.8	6.9	8.0	9.6	8.5	9.8
xi)	140	140.0	140.5	138.3	141.7	2.4	2.0	2.4	3.8	3.2	3.8	5.5	4.8	5.5	7.2	6.3	7.3	8.7	7.7	8.9	10.7	9.5	11.0
xii)	160	160.0	160.5	158.0	162.0	2.8	2.3	2.8	4.3	3.7	4.3	6.2	5.4	6.2	8.2	7.2	8.3	9.9	8.8	10.2	12.2	10.9	12.6
xiii)	180	180.0	180.6	177.8	182.2	3.1	2.6	3.1	4.9	4.2	4.9	7.0	6.1	7.1	9.0	8.0	9.2	11.1	9.9	11.4	13.7	12.2	14.1
xiv)	200	200.0	200.6	197.6	202.4	3.4	2.9	3.4	5.3	4.6	5.3	7.7	6.8	7.9	10.0	8.9	10.3	12.3	11.0	12.7	15.2	13.6	15.7
xv)	225	225.0	225.7	222.3	227.7	3.9	3.3	3.9	6.0	5.2	6.0	8.6	7.6	8.8	11.2	10.0	11.5	13.9	12.4	14.3	17.1	15.3	17.6
xvi)	250	250.0	250.8	247.0	253.0	4.2	3.6	4.2	6.5	5.7	6.5	9.6	8.6	9.8	12.6	11.2	12.9	15.4	13.8	15.9	18.9	17.0	19.6
xvii)	280	280.0	280.9	276.6	283.4	4.8	4.1	4.8	7.3	6.4	7.4	10.7	9.5	11.0	14.0	12.5	14.4	17.2	15.4	17.8	21.1	19.0	21.9
xviii)	315	315.0	316.0	311.2	318.8	5.3	4.6	5.3	8.2	7.2	8.3	12.0	10.7	12.4	15.6	14.0	16.1	19.3	17.3	19.9	23.8	21.4	24.7
xix)	355	355.0	356.1	350.7	359.3	5.9	5.1	5.9	9.2	8.1	9.4	13.4	12.0	13.8	17.6	15.8	18.2	21.8	19.6	22.6	26.8	24.1	27.8
xx)	400	400.0	401.2	395.2	404.8	6.6	5.8	6.7	10.3	9.1	10.5	15.1	13.5	15.6	19.8	17.8	20.5	24.4	22.0	25.3	30.2	27.2	31.3
xxi)	450	450.0	451.4	444.6	455.4	7.4	6.5	7.5	11.6	10.3	11.9	17.0	15.2	17.5	22.2	20.0	23.0	27.5	24.8	28.6	33.8	30.5	35.1
xxii)	500	500.0	501.5	494.0	506.0	8.2	7.2	8.3	12.8	11.4	13.2	18.8	16.9	19.5	24.8	22.3	25.7	30.5	27.5	31.7	37.5	33.9	39.0
xxiii)	560	560.0	561.7	553.2	566.8	9.2	8.1	9.4	14.3	12.8	14.8	21.0	18.9	21.8	27.6	24.9	28.7	34.1	30.8	35.5	42.0	38.0	43.7
xxiv)	630	630.0	631.9	622.4	637.6	10.3	9.1	10.5	16.1	14.4	16.6	23.7	21.3	24.5	31.0	28.0	32.2	38.4	34.7	40.0	47.2	42.7	49.2

NOTES —

1) The table is based on metric series of pipe dimensions given in ISO 161/1 in respect of pipe dimensions and ISO DIS 4422.

2) The wall thickness of pipes is based on a safe working stress of 8.6 MPa at 27^0 C and the working pressure gets reduced at sustained higher temperatures occasional rise intemperature as in summer season withconcurrent corresponding reduction in temperature during nights has no deleterious effect on the life working pressure of the pipes Considering the total life of pipes.

3) For class 1,2 and 3 of all sizes, this requirement need not to be satisfied as the ratio of minimum wall thickness to nominal outside diameter does not exceed 0.035 in these cases.

Table 14 Wall Thickness of Pipes for Material Grade PE 63(IS 4984)

All dimensions in millimetres.

Sl No.	Nominal Dia	Wall Thickness Of Pipes for Pressure Ratings of													
		PN 2.5		PN 4		PN 6		PN 8		PN 10		PN 12.5		PN 16	
	DN	min	max	min	max	min	max	min	max	min	max	min	max	min	max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
i)	20	–	–	–	–	–	–	–	–	2.3	2.8	2.8	3.3	3.4	4.0
ii)	25	–	–	–	–	–	–	2.3	2.8	2.8	3.3	3.4	4.0	4.2	4.9
iii)	32	–	–	–	–	2.3	2.8	3.0	3.5	3.6	4.2	4.4	5.1	5.4	6.2
iv)	40	–	–	2.0	2.4	2.8	3.3	3.7	4.3	4.5	5.2	5.5	6.3	6.7	7.6
v)	50	–	–	2.4	2.9	3.5	4.1	4.6	5.3	5.6	6.4	6.8	7.7	8.4	9.5
vi)	63	2.0	2.4	3.0	3.5	4.4	5.1	5.8	6.6	7.0	7.9	8.6	9.7	10.5	11.8
vii)	75	2.3	2.8	3.6	4.2	5.3	6.1	6.9	7.8	8.4	9.5	10.2	11.5	12.5	14.0
viii)	90	2.8	3.3	4.3	5.0	6.3	7.2	8.2	9.3	10.0	11.2	12.2	13.7	15.0	16.7
ix)	110	3.4	4.0	5.3	6.1	7.7	8.7	10.0	11.2	12.3	13.8	14.9	16.6	18.4	20.5
x)	125	3.8	4.4	6.0	6.8	8.8	9.9	11.4	12.8	13.9	15.5	16.9	18.8	20.9	23.2
xi)	140	4.3	5.0	6.7	7.6	9.8	11.0	12.8	14.3	15.6	17.4	19.0	21.1	23.4	26.0
xii)	160	4.9	5.6	7.7	8.7	11.2	12.6	14.6	16.3	17.8	19.8	21.7	24.1	26.7	29.6
xiii)	180	5.5	6.3	8.6	9.7	12.6	14.1	16.4	18.3	20.0	22.2	24.4	27.1	30.0	33.2
xiv)	200	6.1	7.0	9.6	10.8	14.0	15.6	18.2	20.3	22.3	24.8	27.1	30.1	33.4	37.0
xv)	225	6.9	7.8	10.8	12.1	15.7	17.5	20.5	22.8	25.0	27.7	30.5	33.8	37.5	41.5
xvi)	250	7.6	8.6	12.0	13.4	17.5	19.5	22.8	25.3	27.8	30.8	33.8	37.4	41.7	46.1
xvii)	280	8.5	9.6	13.4	15.0	19.6	21.8	25.5	28.3	31.2	34.6	37.9	41.9	46.7	51.6
xviii)	315	9.6	10.8	15.0	16.7	22.0	24.4	28.7	31.8	35.0	38.7	42.6	47.1	52.5	58.0
xix)	355	10.8	12.1	17.0	18.9	24.8	27.5	32.3	35.8	39.5	43.7	48.0	53.0	59.2	65.4
xx)	400	12.2	14.3	19.1	22.2	28.0	32.4	36.4	42.1	44.5	51.4	54.1	62.5	–	–
xxi)	450	13.7	16.0	21.5	25.0	31.4	36.4	41.0	47.4	50.0	57.7	–	–	–	–
xxii)	500	15.2	17.7	23.9	27.7	34.9	40.4	45.5	52.6	55.6	64.2	–	–	–	–
xxiii)	560	17.0	19.8	26.7	31.0	39.1	45.2	51.0	58.9	–	–	–	–	–	–
xxiv)	630	19.1	22.2	30.0	34.7	44.0	50.8	57.3	66.1	–	–	–	–	–	–
xxv)	710	21.6	25.1	33.9	39.2	49.6	57.3	–	–	–	–	–	–	–	–
xxvi)	800	24.3	28.2	38.1	44.1	55.9	64.5	–	–	–	–	–	–	–	–
xxvii)	900	27.3	31.6	42.9	49.6	–	–	–	–	–	–	–	–	–	–
xxviii)	1000	30.4	35.2	47.7	55.1	–	–	–	–	–	–	–	–	–	–

Table 15Wall Thickness of Pipes for Material GradePE 80
(IS 4984)

All dimensions in millimetres.

Sl No.	Nominal Dia	Wall Thickness of Pipes for Pressure Ratings of													
		PN 2.5		PN 4		PN 6		PN 8		PN 10		PN 12.5		PN 16	
	DN	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
i)	20	–	–	–	–	–	–	–	–	–	–	2.3	2.8	2.8	3.3
ii)	25	–	–	–	–	–	–	–	–	2.3	2.8	2.8	3.3	3.5	4.1
iii)	32	–	–	–	–	–	–	2.4	2.9	3.0	3.5	3.6	4.2	4.5	5.2
iv)	40	–	–	–	–	2.3	2.8	3.0	3.5	3.7	4.3	4.5	5.2	5.6	6.4
v)	50	–	–	2.3	2.8	2.9	3.4	3.8	4.4	4.6	5.3	5.6	6.4	6.9	7.8
vi)	63	–	–	2.5	3.0	3.6	4.2	4.7	5.4	5.8	6.6	7.0	7.9	8.7	9.8
vii)	75	–	–	2.9	3.4	4.3	5.0	5.6	6.4	6.9	7.8	8.4	9.5	10.4	11.7
viii)	90	2.3	2.8	3.5	4.1	5.1	5.9	6.7	7.6	8.2	9.3	10.0	11.2	12.5	14.0
ix)	110	2.7	3.2	4.3	5.0	6.3	7.2	8.2	9.3	10.0	11.2	12.3	13.8	15.2	17.0
x)	125	3.1	3.7	4.9	5.6	7.1	8.1	9.3	10.5	11.4	12.8	13.9	15.5	17.3	19.3
xi)	140	3.5	4.1	5.4	6.2	8.0	9.0	10.4	11.7	12.8	14.3	15.6	17.4	19.4	21.6
xii)	160	4.0	4.6	6.2	7.1	9.1	10.3	11.9	13.3	14.6	16.3	17.8	19.8	22.1	24.6
xiii)	180	4.4	5.1	7.0	7.9	10.2	11.5	13.4	15.0	16.4	18.3	20.0	22.2	24.9	27.6
xiv)	200	4.9	5.6	7.7	8.7	11.4	12.8	14.9	16.6	18.2	20.3	22.3	24.8	27.6	30.6
xv)	225	5.5	6.3	8.7	9.8	12.8	14.3	16.7	18.6	20.5	22.8	25.0	27.7	31.1	34.5
xvi)	250	6.1	7.0	9.7	10.9	14.2	15.9	18.6	20.7	22.8	25.3	27.8	30.8	34.5	38.2
xvii)	280	6.9	7.8	10.8	12.1	15.9	17.7	20.8	23.1	25.5	28.3	31.2	34.6	38.7	42.8
xviii)	315	7.7	8.7	12.2	13.7	17.9	19.9	23.4	26.0	28.7	31.8	35.0	38.7	43.5	48.1
xix)	355	8.7	9.8	13.7	15.3	20.1	22.4	26.3	29.2	32.3	35.8	39.5	43.7	49.0	54.1
xx)	400	9.8	11.5	15.4	18.0	22.7	26.4	29.7	34.4	36.4	42.1	44.5	51.4	55.2	63.7
xxi)	450	11.0	12.9	17.4	20.3	25.5	29.6	33.4	38.7	41.0	47.4	50.0	57.7	–	–
xxii)	500	12.2	14.3	19.3	22.4	28.4	32.9	37.1	42.9	45.5	52.6	55.6	64.2	–	–
xxiii)	560	13.7	16.0	21.6	25.1	31.7	36.7	41.5	48.0	51.0	58.9	–	–	–	–
xxiv)	630	15.4	18.0	24.3	28.2	35.7	41.3	46.7	54.0	57.3	66.1	–	–	–	–
xxv)	710	17.4	20.3	27.4	31.8	40.2	46.5	52.6	60.7	–	–	–	–	–	–
xxvi)	800	19.6	22.8	30.8	35.7	45.3	52.3	–	–	–	–	–	–	–	–
xxvii)	900	22.0	25.5	34.7	40.2	51.0	58.9	–	–	–	–	–	–	–	–
xxviii)	1000	24.4	28.3	38.5	44.5	56.7	65.5	–	–	–	–	–	–	–	–

Table 16 Wall Thickness of Pipes for Material Grade PE 100 (IS 4984)

All dimensions in millimetres.

Sl No.	**Nominal Dia**	**Wall Thickness Of Pipes For Pressure Ratings of**									
		PN 6		**PN 8**		**PN 10**		**PN 12.5**		**PN 16**	
	DN	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	20	–	–	–	–	–	–	–	–	2.3	2.8
ii)	25	–	–	–	–	–	–	2.3	2.8	2.9	3.4
iii)	32	–	–	–	–	2.4	2.9	2.9	3.4	3.7	4.3
iv)	40	–	–	2.4	2.9	3.0	3.5	3.7	4.3	4.6	5.3
v)	50	2.3	2.8	3.0	3.5	3.7	4.3	4.6	5.3	5.7	6.5
vi)	63	2.9	3.4	3.8	4.4	4.7	5.4	5.7	6.5	7.1	8.1
vii)	75	3.5	4.1	4.5	5.2	5.6	6.4	6.8	7.7	8.5	9.6
viii)	90	4.1	4.8	5.4	6.2	6.7	7.6	8.2	9.3	10.2	11.5
ix)	110	5.0	5.7	6.6	7.5	8.1	9.2	10.0	11.2	12.4	13.9
x)	125	5.7	6.5	7.5	8.5	9.2	10.4	11.3	12.7	14.1	15.8
xi)	140	6.4	7.3	8.4	9.5	10.3	11.6	12.7	14.2	15.8	17.6
xii)	160	7.3	8.3	9.6	10.8	11.8	13.2	14.5	16.2	18.1	20.2
xiii)	180	8.2	9.3	10.8	12.1	13.3	14.9	16.3	18.2	20.3	22.6
xiv)	200	9.1	10.3	12.0	13.4	14.8	16.5	18.1	20.2	22.6	25.1
xv)	225	10.3	11.6	13.5	15.1	16.6	18.5	20.4	22.7	25.4	28.2
xvi)	250	11.4	12.8	15.0	16.7	18.4	20.5	22.6	25.1	28.2	31.3
xvii)	280	12.8	14.3	16.8	18.7	20.6	22.9	25.3	28.1	31.6	35.0
xviii)	315	14.4	16.1	18.9	21.0	23.2	25.8	28.5	31.6	35.5	39.3
xix)	355	16.2	18.1	21.2	23.6	26.2	29.1	32.1	35.6	40.0	44.2
xx)	400	18.2	21.2	23.9	27.7	29.5	34.2	36.2	41.9	45.1	52.1
xxi)	450	20.5	23.8	26.9	31.2	33.1	38.3	40.7	47.1	50.8	58.7
xxii)	500	22.8	26.5	29.9	34.6	36.8	42.6	45.2	52.2	56.4	65.1
xxiii)	560	25.5	29.6	33.5	38.8	41.2	47.6	50.6	58.4	–	–
xxiv)	630	28.7	33.3	37.7	43.6	46.4	53.6	56.9	65.7	–	–
xxv)	710	32.3	37.4	42.4	49.0	52.3	60.4	–	–	–	–
xxvi)	800	36.4	42.1	47.8	55.2	58.9	68.0	–	–	–	–
xxvii)	900	41.0	47.4	53.8	62.1	–	–	–	–	–	–
xxviii)	1000	45.5	52.6	–	–	–	–	–	–	–	–

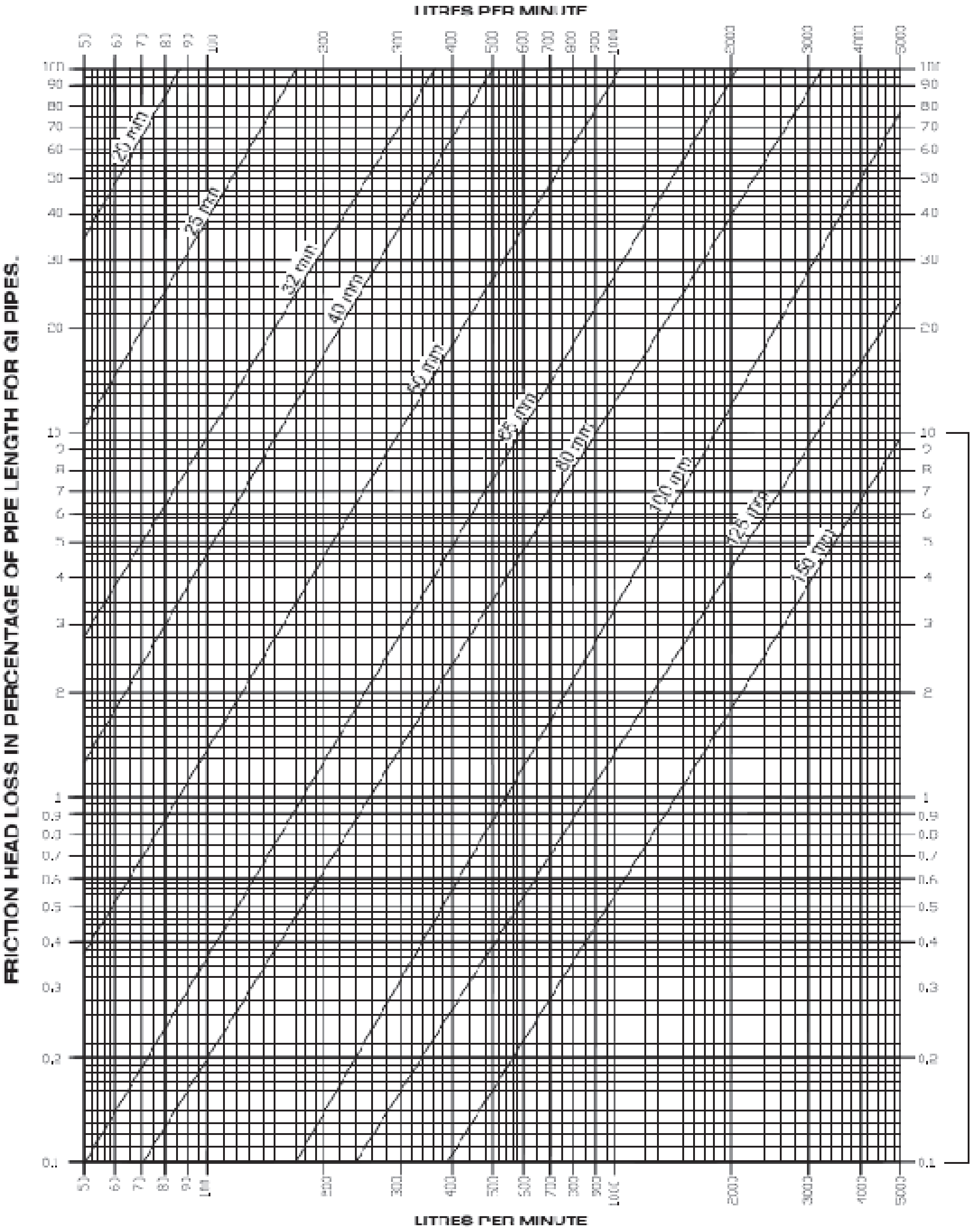


FIG. 1 FRICTION HEAD LOSS SELECTION CHART FOR GI PIPES

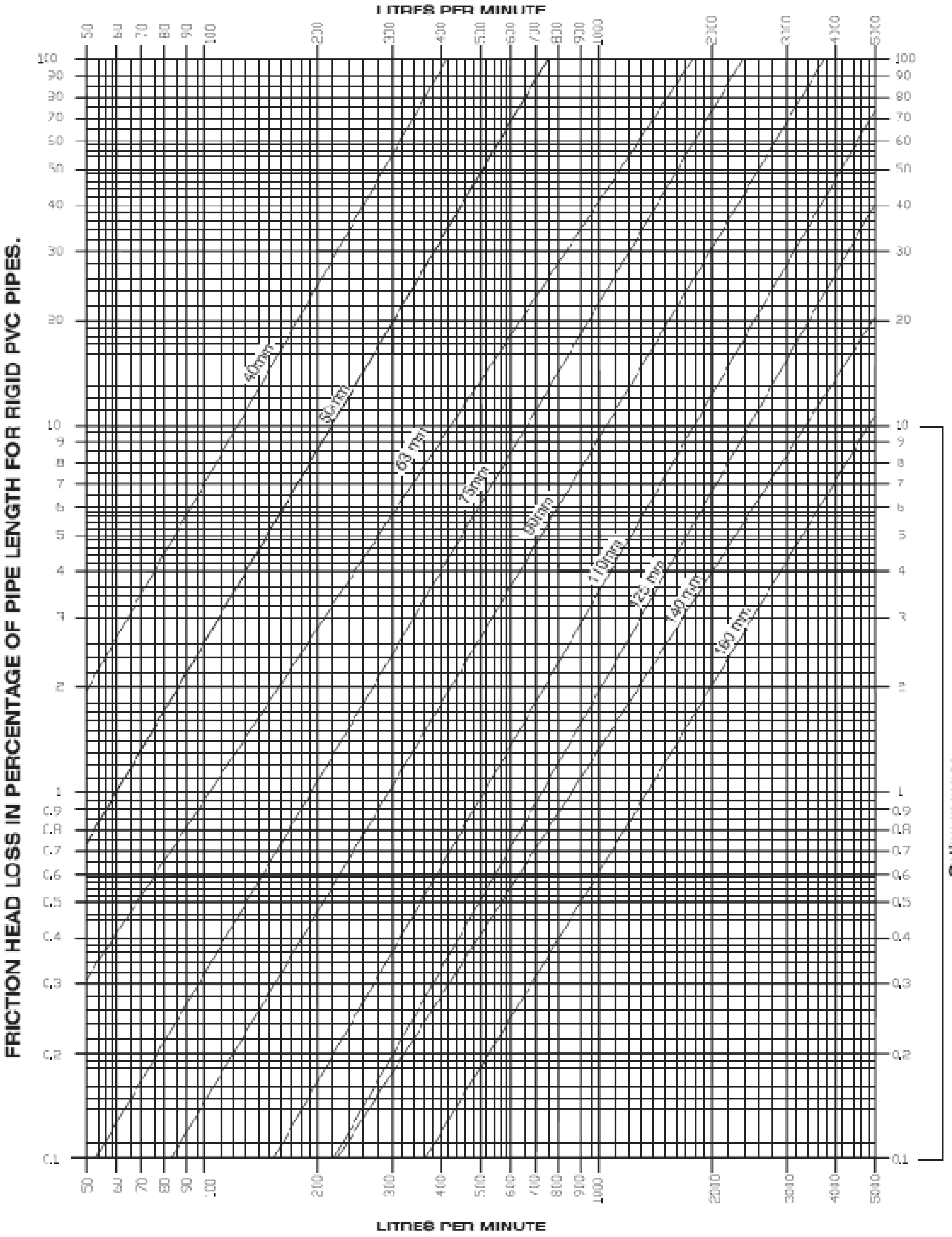


FIG. 2 FRICTION HEAD LOSS SELECTION CHART FOR RIGID PVC (Class 3,6 kg/cm^2)

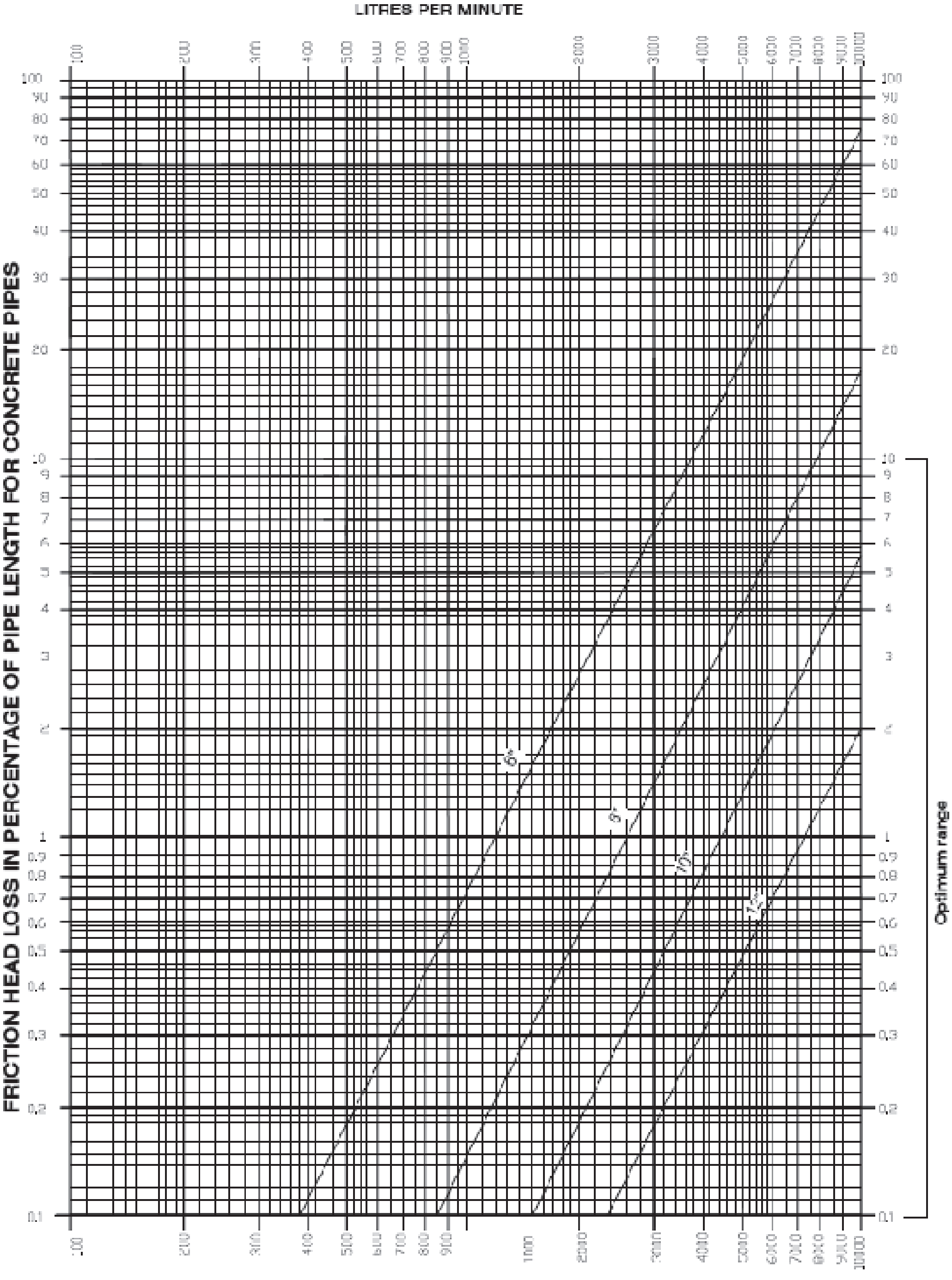


FIG. 3 FRICTION HEAD LOSS SELECTION CHART FOR CONCRETE PIPES

7.6 Prime Mover — Prime mover rating is to be selected such that it does not get overloaded in the entire operating head range with a minimum of 20 percent margin.

8 POWER SUPPLY

8.1 Preferred Voltage and Frequency

8.1.1 *Preferred Voltage*

The preferred rated voltage shall be 415 V for three phase motors and 240 V for single phase motors (*See* IS 12360)

8.1.2 *Preferred Frequency*

The preferred rated frequency shall be 50Hz

8.2 Voltage and Frequency Variation

8.2.1 *Category 'A'*

The motors shall be capable of delivering rated output with:

a) The terminal voltage differing from the rated value by not more than ± 6 percent;
b) The rated frequency differing from the rated value by not more than ±3 percent; and
c) Combination of (a) and (b).

8.2.2 *Category 'B'*

The motors shall be capable of delivering rated output with:

a) The terminal voltage differing from the rated value by not more than + 6/–15 percent;
b) The rated frequency differing from the rated value by not more than ±3 percent; and
c) Combination of (a) and (b).

9 PROTECTION DEVICES — FOR MOTOR

9.1 Starters

The submersible motor should be operated with starting devices as per manufacturer recommendation such as DOL, Star Delta or Auto transformer Starter. The Starter should have indicting instruments like ammeter and voltmeter of suitable range, over load indicators for each phase. The overload protection should be preset as near as possible to the operating current value and never higher than the rated motor current. The enclosure should be water tight, dust proof construction and it should be earth protected. The control switch gears and wires should have a sufficient rating to carry the operating current. The insulation material should withstand at extreme temperature limits. The motor should be connected in accordance with wiring diagrams shown inside the controller. The starter should be mounted vertically.

9.2 Dry Running

A special device with a relay and electrodes to be provided to protect the pump set from dry running. It should be used in all cases where the water level varies widely. Location of the electrode shall be at minimum of 1 metre from the pump Discharge Outlet Level.

9.3 Single Phase Preventers

Preventer must be installed in all three phase pump set panel to protect the winding from burn outs due to the absence of any one of the phase out of three phase supply. The phase failure occurs due to blown fuse or breaking conductor or any kind of discontinuity in the electric power transmission. It is a condition of heavy imbalance and motor draws more current.

9.4 Earthing

Suitable provisions for earthing of the motor shall be provided at the time of installation as specified in IS 3043. In case GI pipes are used for the purpose of earthing the motor, the earthing connection may be made on to the supporting pipe clamp.

9.5 Cable Selection

Cables used shall be as per IS 694.

Correct cable size is to be selected as per Table 17 and Table 18

From the bore-well entry point to panel board a higher size cable to be selected to avoid excess voltage drop. The extra cable should not be placed in coil form.

9.6 Cable Joint

Joining submersible pump set cable is part of every submersible pump set installation because every submersible pump installation has at least one joint between the motor leads and the pump cable.

Although it some-times is necessary to join two lengths of pump cable together in very deep-set applications, it is always better to use a single length of pump cable from the surface to the motor lead. A good joint is watertight, has good electrical conductivity and is mechanically strong.

Typical cable joints are given as per Fig. 4.

10 PUMP EFFICIENCY

10.1 *See* Table 1 of IS 8034 for Motor Efficiency factor for 2-Pole, 415 Volt, three phase, water filled submersible motors for bore size minimum 100 mm and maximum OD of Motor 98 mm.

10.2 *See* Table 2 of IS 8034 for Motor Efficiency factor for 2-Pole, 415 Volt, three phase, water filled submersible motors for bore size minimum 150mm and maximum OD of Motor 146 mm.

10.3 *See* Table 3 of IS 8034 for Motor Efficiency factor for 2-Pole, 415 Volt, three phase, water filled submersible motors for bore size minimum 200 mm and maximum OD of Motor 196 mm.

10.4 *See* Table 4 of IS 8034 for Motor Efficiency factor for 2-Pole, 240 Volt, single phase, capacitor start and run (CSR), capacitor start and capacitor run (CSCR), water filled submersible motors for bore size minimum 100 mm and maximum OD of Motor 98 mm.

10.5 *See*Table 5 of IS 8034 for Motor Efficiency factor for 2-Pole, 240 volt, single phase capacitor start and run (CSR), capacitor start and capacitor run (CSCR), oil filled/or encapsulated oil filled, Submersible Motors for bore size minimum 100 mm and maximum OD of Motor 98 mm.

10.6 For Motor Efficiency factor for 2-Pole, 415 Volt, 50 Hz, three phase, water filled submersible motors for open well Submersible pump set *see* Table 2 given in IS 14220 (*first revision*) *UNDER PRINT* for motor efficiency factor.

10.7 *See* Table 4 given in IS 14220 for motor efficiency factor (*first revision*) *UNDER PRINT* Motor Efficiency factor for 4-Pole, 415 Volt, 50 Hz, Three Phase, Water Filled Submersible Motors for open well Submersible pump set.

10.8 *See* Table 3 given in IS 14220 for motor efficiency factor (*first revision*) *UNDER PRINT* Motor Efficiency factor for 2-Pole, 240 Volt, 50 Hz, single phase, water filled submersible motors for open well submersible pump set.

10.9 *See* Fig. 4 and 5 given in IS 8034 for minimum efficiency in percent for 2 pole submersible pump set.

10.10 *See* Fig. 5 and 6 given in IS 14220 (first revision) *UNDER PRINT* for minimum pump efficiency in percent for 4-pole and 2-pole open well submersible pump set respectively (It is 14220 is under WC).

10.11 Please *see* Fig 2 given in IS 8034 for Typical field installation of bore well submersible pump set.

Table 17Cable Selection for Single Phase Motor Maximum Length of Copper Cable (IS 694) For Supply Voltage Condition with Variation of ± 3% - 50Hz

Sl No.	MOTOR RATING			CABLE SIZE SQUARE MILLIMETRES											
	VOLTS	kW	HP	1.5	2.5	4	6	10	16	25	35	50	70	95	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
i)	220/240 VOLT 50Hz	0.37	0.5	120	200	320	480	810	1260	1900	2590	3580	4770	5920	MAXIMUM LENGTH IN METRES
ii)		0.55	0.75	80	130	250	320	550	850	1290	1760	2430	3230	4000	
iii)		0.75	1.0	60	100	170	250	430	670	1010	1380	1910	2550	3160	
iv)		1.10	1.5	40	70	120	180	300	470	710	980	1360	1850	2320	
v)		1.50	2.0	30	60	90	130	230	360	550	760	1060	1440	1820	
vi)		2.20	3.0		40	60	100	170	280	430	600	820	1080	1310	

Table 18 Cable Selection for Three Phase Motor Maximum Length of Copper Cable (IS 694) For Supply Voltage Condition with Variation of ± 3% - 50Hz

Sl No.	MOTOR RATING			CABLE SIZE SQUARE MILLIMETRES												
	VOLTS	kW	HP	1.5	2.5	4	6	10	16	25	35	50	70	95	120	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
i)	380/ 415 VOLT 50Hz	0.75	1.0	380	630	1020	1525	2595	4032	6111	8366					MAXIMUM LENGTH IN METRES
ii)		1.10	1.5	300	500	810	1210	2060	3200	4850	6640	9220				
iii)		1.50	2.0	220	370	590	880	1500	2340	3560	4890	6830	9230			
iv)		2.20	3.0	150	250	400	600	1030	1600	2440	3350	4680	6340	7990		
v)		3.00	4.0	110	190	310	460	790	1230	1880	2590	3630	4930	6230		
vi)		3.70	5.0	90	150	240	370	630	980	1490	2050	2870	3900	4920		
vii)		4.00	5.5	80	140	230	340	590	920	1390	1910	2670	3600	4520		
viii)		4.50	6.0	70	130	220	320	550	860	1310	1790	2510	3390	4260		
ix)		5.50	7.5	60	110	170	260	440	690	1060	1450	2030	2750	3460		
x)		7.50	10.0	50	80	130	200	340	530	810	1110	1560	2120	2680		
xi)		9.30	12.5		60	110	160	280	440	670	920	1310	1780	2250		
xii)		11.0	15.0		50	90	130	230	360	550	750	1060	1440	1820		
xiii)		13.0	17.5			80	110	200	310	480	650	920	1250	1580		
xiv)		15.0	20.0			70	100	170	270	410	570	800	1080	1370		
xv)		18.5	25.0				80	140	210	330	450	630	860	1090		
xvi)		22.0	30.0				70	120	180	280	380	540	740	930		
xvii)		26.0	35.0					100	150	230	310	440	610	770	870	
xviii)		30.0	40.0					90	130	210	280	400	540	680	780	
xix)		37.0	50.0						110	170	230	320	440	550	700	
xx)		45.0	60.0							140	190	260	360	460	560	
xxi)		56.0	75.0								160	220	290	380	340	
xxii)		75.0	100.0									160	220	280	340	

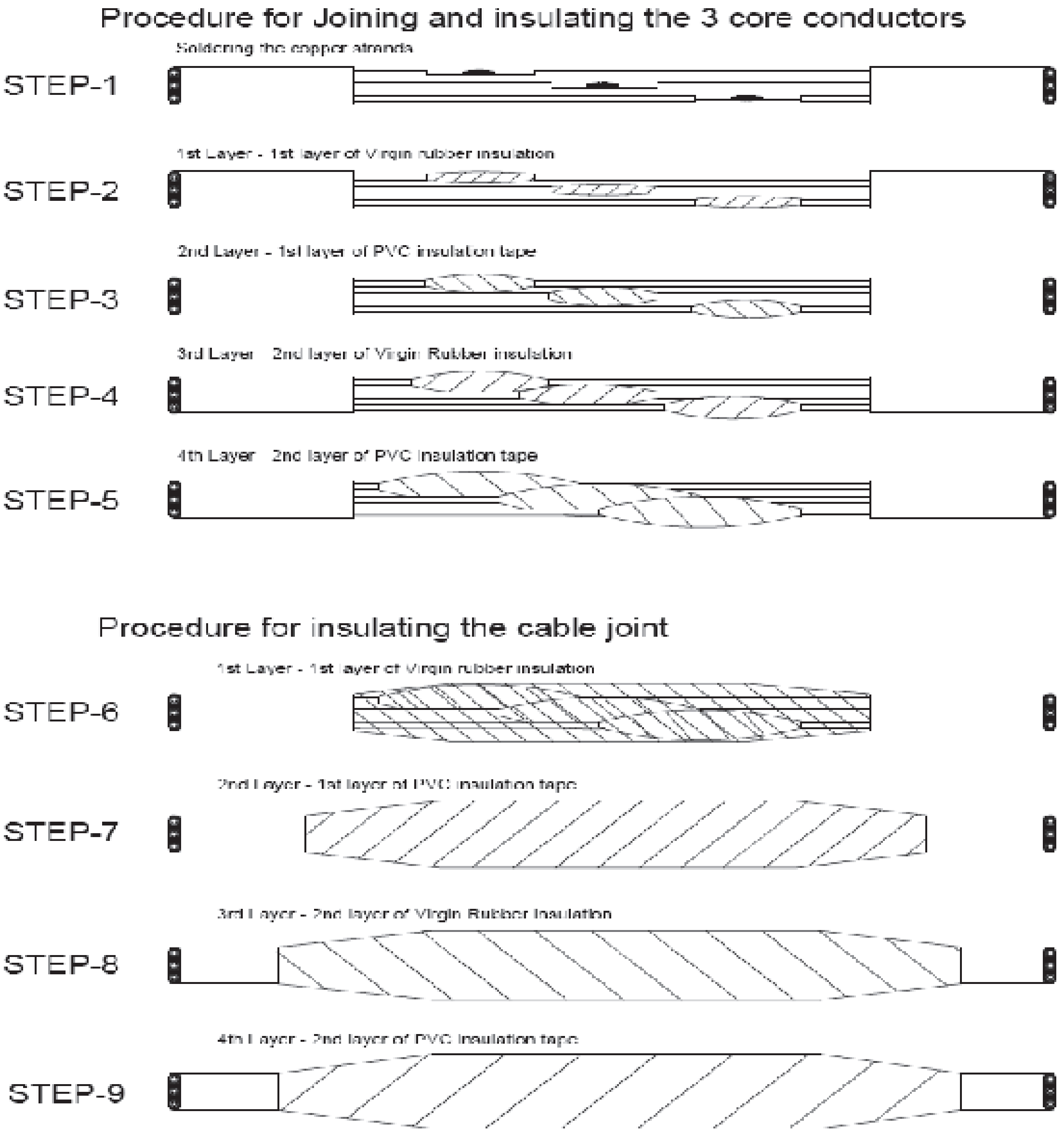

Procedure for Joining and insulating the 3 core conductors
Soldering the copper strands
STEP-1
1st Layer - 1st layer of Virgin rubber insulation
STEP-2
2nd Layer - 1st layer of PVC insulation tape
STEP-3
3rd Layer 2nd layer of Virgin Rubber insulation
STEP-4
4th Layer 2nd layer of PVC insulation tape
STEP-5
Procedure for insulating the cable joint
1st Layer - 1st layer of Virgin rubber insulation
STEP-6
2nd Layer - 1st layer of PVC insulation tape
STEP-7
3rd Layer - 2nd layer of Virgin Rubber Insulation
STEP-8
4th Layer - 2nd layer of PVC insulation tape
STEP-9

FIG. 4 CABLE JOINING

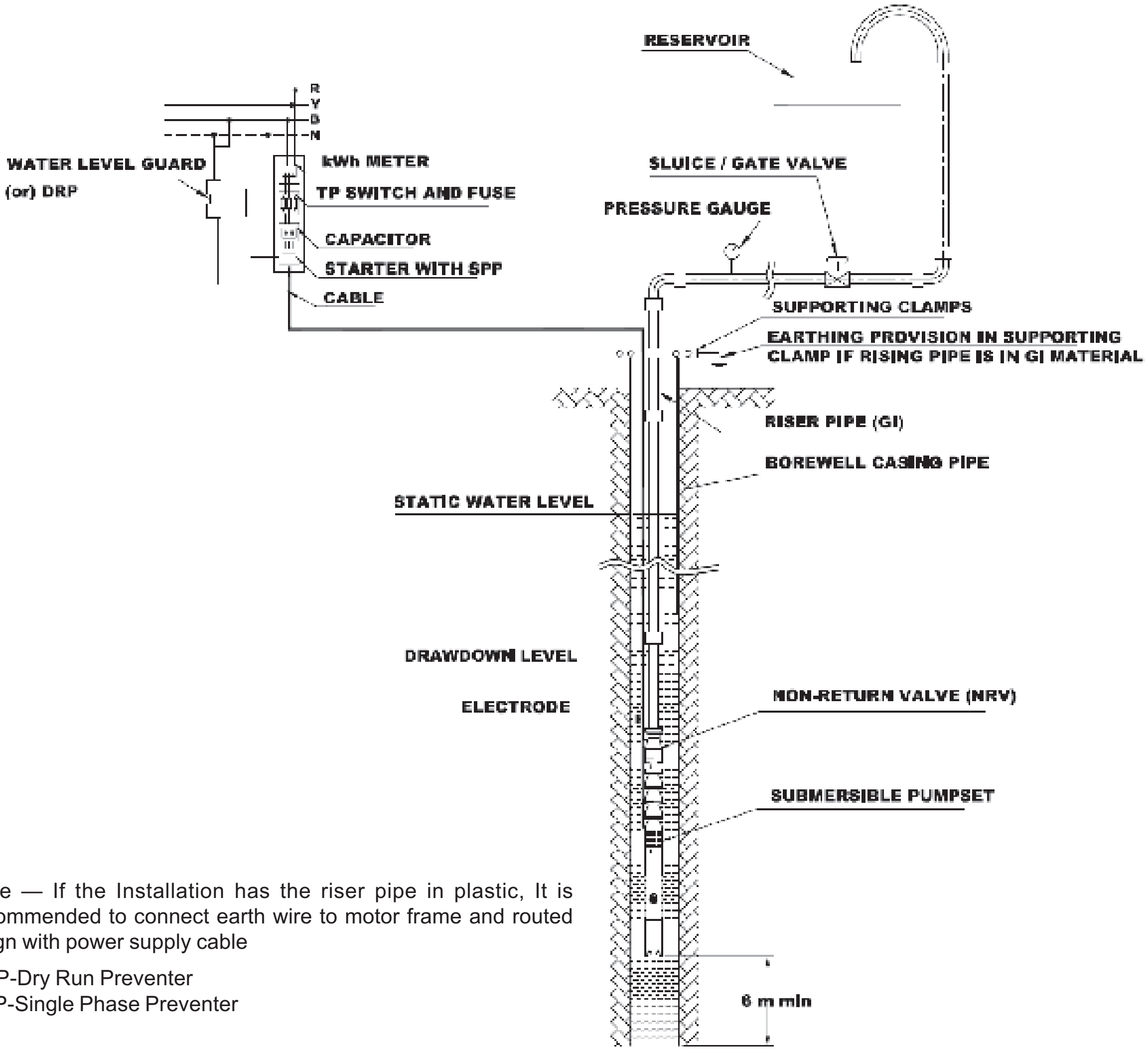
After starting the test pump set, the water level in the bore-well which is at the “SWL” in the beginning will go to “DDL” level after 30 minutes of time (approx.) and stabilize there. At that time, if the control valve is closed and “PGR” Pressure Gauge Reading (in m) is noted down, it will show the balance of shut-off head of the test pump set after deducting the DDL (in m).

Pressure Gauge Reading (m) = Shut off Head of the test pump (m) at the Ground level - Draw Down Level (m)

PGR = SOH – DDL

Draw Down Level (m) = Shut off Head of the test pump (m) - Pressure Gauge reading (m) at the ground level

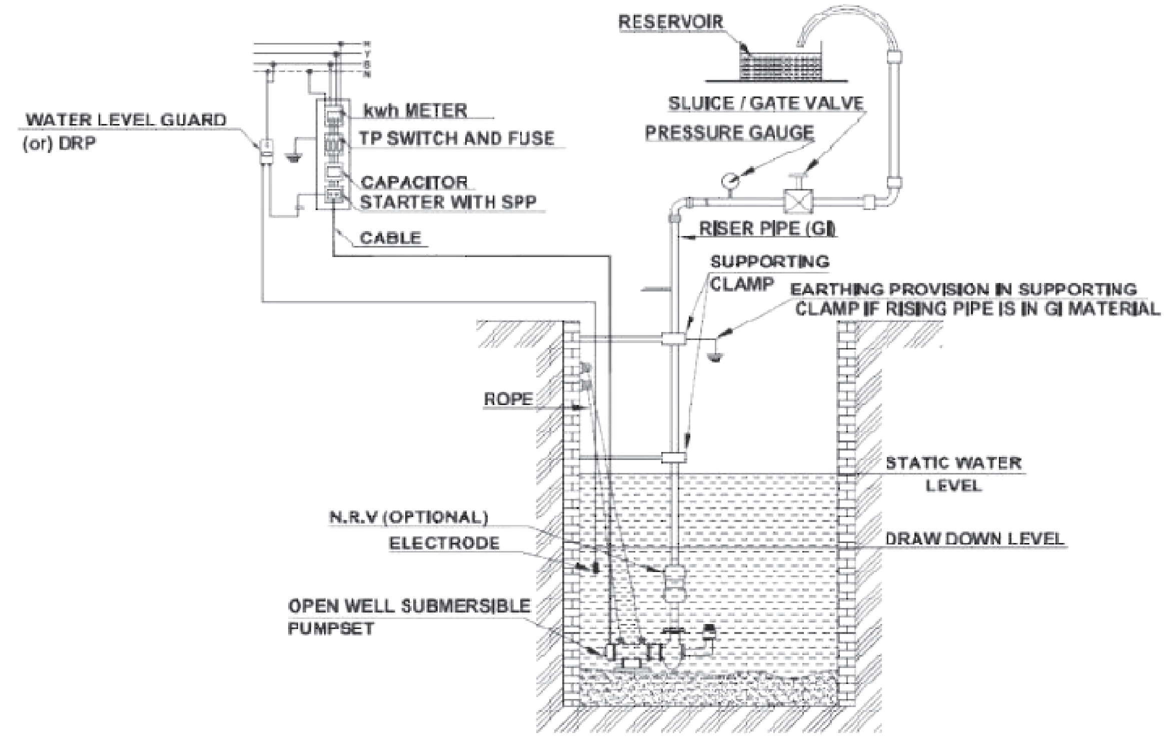
Now, the control valve is fully opened and the water flow is channeled into a 90° V-Notch plate and the “head over the notch” is noted down. From the formula given in the IS 11346, clause **3.2.1.2**, volume rate offlow is calculated.



Note — If the Installation has the riser pipe in plastic, It is recommended to connect earth wire to motor frame and routed alogn with power supply cable

DRP-Dry Run Preventer
SPP-Single Phase Preventer

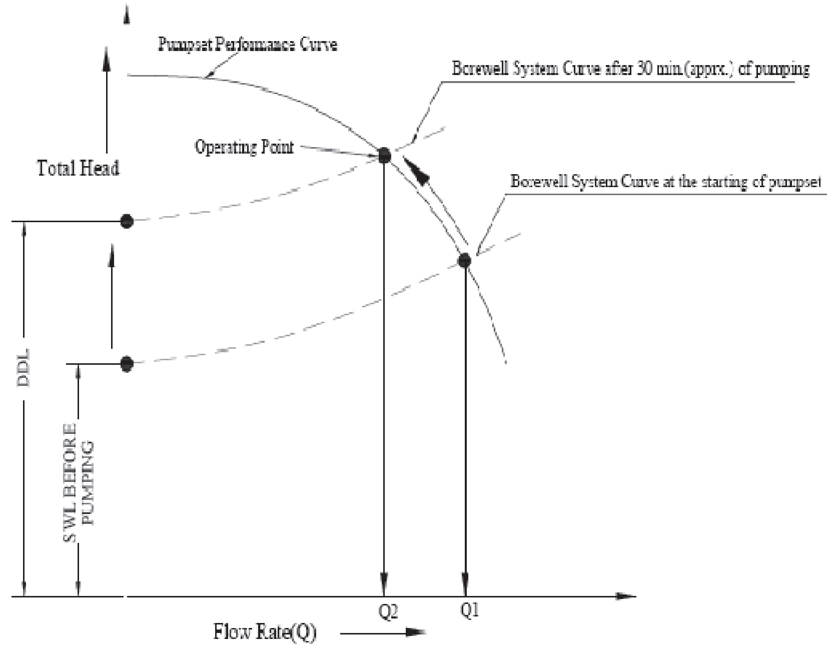
FIG. 5 TYPICAL FIELD INSTALLATION OF BORE WELL SUBMERSIBLE PUMP SET



Note — If installation has the riser pipe in plastic, it is recommended to connect earth wire to motor frame and routed along with power supply cable

DRP-Dry Run Preventer
SPP-Single Phase Preventer

FIG. 6 TYPICAL FIELD INSTALLATION OF OPEN WELL SUBMERSIBLE PUMP SET



Q1 = Flow rate at the starting of the pumpset DDL = Draw Down Level
Q2 = Flow rate after 30 min. (apprx.),
after attaining the DDL (stable pumping)SWL = Static Water Level (before pumping)

FIG. 7 BORE-WELL SYSTEM CURVE, PUMP PERFORMANCE CURVE AND OPERATING POINT

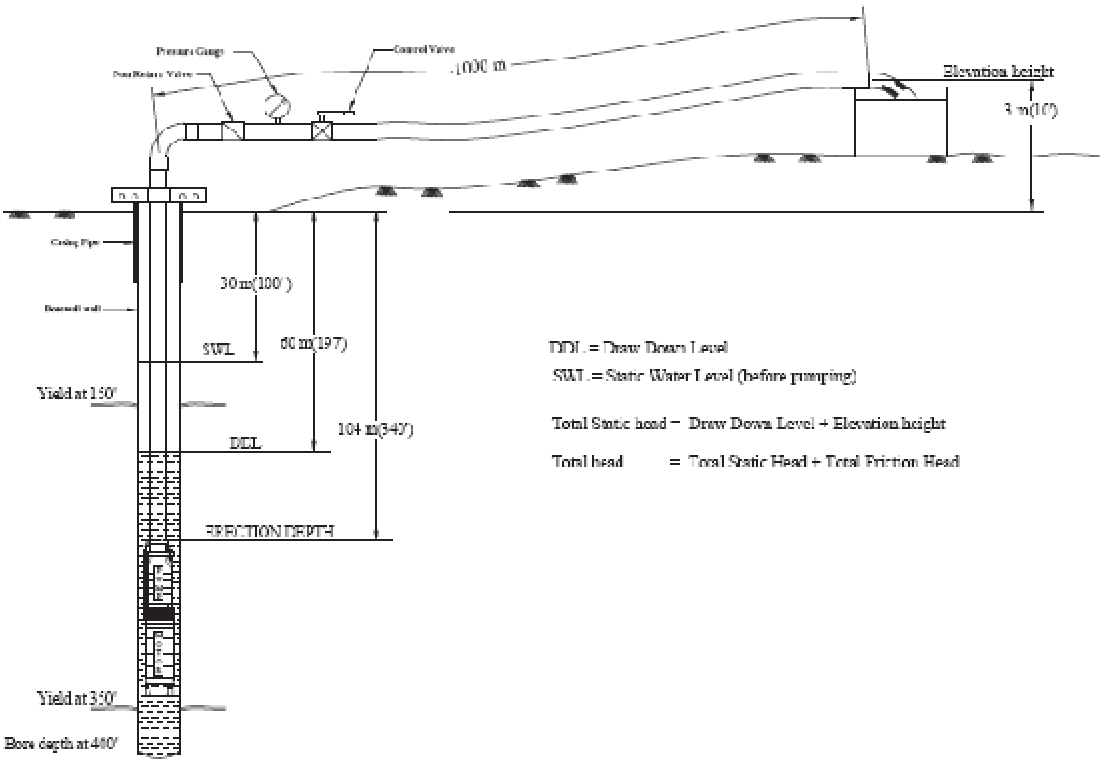


FIG. 8 PUMP SELECTION AND ERECTION DIAGRAM FOR THE EXAMPLE IN ANNEX 'B'

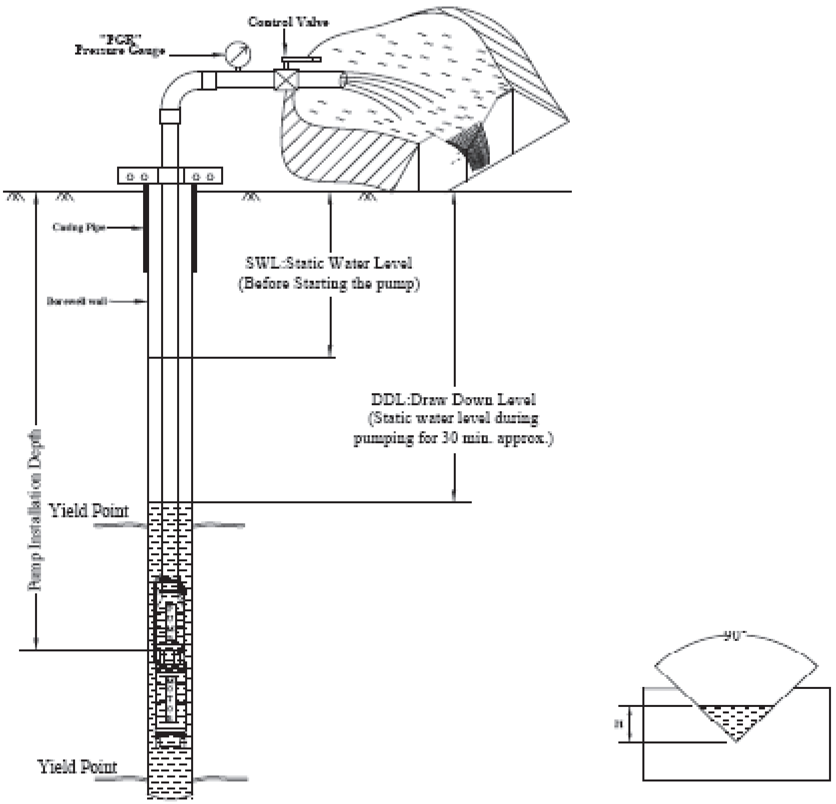


FIG. 9 TYPICAL SUBMERSIBLE PUMP SET YIELD TESTING

ANNEX A

(*Clause* 2)

LIST OF REFERENCE STANDARDS

IS No.	*Title*
694 : 2010	Polyvinyl chloride insulated unsheathed and sheathed cables/cords with rigid and flexible conductor for rated voltages up to and including 450/750 V
1239	Steel tubes, tubulars and other wrought steel fittings
(Part 1) : 2004	Steel tubes (*sixth revision*)
(Part 2) : 2011	Steel pipe fittings (*fifth revision*)
2800	Code of practice for construction and testing of tubewells/Borewells
(Part 1) : 1991	Part 1 Construction (*second revision*)
(Part 2) : 1979	Testing (*first revision*)
3043 : 1987	Code of practice for earthing (*first revision*)
4984 : 1995	Specification for high density polyethylene pipes for water supply, (*fourth revision*)
4985 : 2000	Specification for unplasticised PVC pipes for potable water supplies (*third revision*)
8034 : 2002	Submersible pump sets — specification (*second revision*)
9283 : 2013	Motors for submersible pump sets — specification (*second revision*)
9694 (Part 1) : 1987	Code of practice for the selection, installation, operation and maintenance of horizontal centrifugal pumps for agricultural applications : Part 1 selection (*first revision*)
10124 (Part 8) : 2009	Specification for fabricated PVC — U fittings for potable water supplies: Part 8 Specific requirements for 90 degree bends (*second revision*)
11346 : 2002	Tests for agricultural and water supply pumps — Code of acceptance (*first revision*)
12231 : 1987	Specification for unplasticised PVC pipes for use in suction and delivery lines of agricultural pump sets
12360 : 1988	Voltage bands for electrical installations including preferred voltages and frequency
13593 : 1992	UPVC pipe fittings to be used with the UPVC pipes in the suction and delivery lines of agricultural pumps — Specification
14220 : 1994	Open well submersible pump sets (*first revision*) (*under print*)
14536 : 1998	Selection, installation, operation and maintenance of submersible pump set — Code of practice. (*first revision*) (*under print*)

ANNEX B

EXAMPLE FOR SELECTION OF SUBMERSIBLEPUMP SET FOR AGRICULTURAL REQUIREMENT

Example:

Bore-well size : 150 mm
Bore-well depth : 137 m (400')
First Yield point : 46 m (150')
Second Yield point : 107 m (350')
Yield of the bore-well : 265 lpm
Discharge requirement of the farmer for his agricultural usage : 200 lpm
Static water level from the ground level before pumping : 30 m (100')
Horizontal distance of the delivery point from the bore-well : 1000 m
Elevation height of the delivery point from the ground level : 3 m (10')
Average draw down level assumed : 60 m (197')

See Fig 12 - Pump selection and erection diagram for the example in Annex B.

A suitable submersible pump set, GI column pipe and RPVC discharge pipe line are to be selected for this application.

Solution:

Pump set is to be erected at 104 m (340') just above the last yield point at 107 m (350').

B-1 DISCHARGE RATE

The discharge rate required for the application: 200 lpm

B-2 TOTAL HEAD CALCULATION

Total Head = Static head + Total Friction head in the piping system + Velocity head at the outlet point

B-2.1Static Head Calculation:

Static head = Drawdown level + Elevation height

= 60 m + 3 m

= 63 m.

B-2.2 Friction Head Calculation:

B-2.3 For The GI Column Pipe — For the discharge rate of 200 lpm a 2" GI column pipe can be selected for the erection depth of 104 m from the Table 8 or Fig1 in the optimum range which results in 4.6 percent friction loss for 2" GI pipe and fittings.

Friction head for 2" GI Column pipe

= 104 x (4.6/100) = 4.78 m

B-2.4 For The GI Pipe Fittings — On the ground level a 2" bend, 2"NRV and 2" control valve are to be used. The same friction head loss of 4.6 percent for the discharge rate of 200 lpm is to be applied to the length of 2" straight pipe which gives equivalent friction head loss in the 2" GI pipe fittings.

Length of straight pipe in meters giving equivalent friction head loss in pipe fittings, valves are given in Table 11.

Equivalent length of 2"bend, 2"NRV and 2"control valve= 1.28 m + 3.96 m+ 0.37m = 5.61m

Friction head for 2" GI fittings = 5.61 x (4.6/100) = 0.25 m

B-2.4 For the RPVC Delivery Pipe— Since the distance of water transfer is long (1000 m) we can select higher pipe size to reduce the friction loss.

For the discharge rate of 200 lpm, a 63mm RPVC pipe can be selected for delivery length of 1000 m from the Table 9 or Fig 2 in the optimum range which results in 2.8% friction loss.

Friction head for 63 mm RPVC pipe = 1000 x (2.8/100) = 28 m

B-2.5 Total Friction head — Total Friction head = Friction head for 2" GI Column pipe + Friction head for 2" GI fittings + Friction head for 63 mm RPVC pipe

= 4.78+0.25+28

= 33.03 m

B-2.6 Velocity Head — Velocity of flow for 200 lpm in 63 mm RPVC pipe = 1.3 m/s

Velocity head = $V^2 /2g$

= $1.3^2 / 2 \times 9.81$ = 0.09m

B-2.7 Total Head— Total Head = Static head + Total Friction head in the piping system + Velocity head at the outlet point

= 63+33.03+0.09

= 96.12 m = 96 m.

3 SELECTION OF PUMP SET AND RECOMMENDED PRIME MOVER RATING

3.1 A suitable bore-wellpump set is to be selected for the total head of 96 m and discharge rate of 200 lpm 200 lpm.

Approximate number of stages of the pump set

= Total head / 8 m per stage head for 150 mm bore-wellpump sets

= 96/8 = 12 stages.

3.2 The minimum pump efficiency in percentage for 2 pole submersible pump set as per IS 8034 for

8 m head and 200lpm (3.33 l/s) discharge is 54%.

Duty point power in kW

= Total head in m x Discharge rate in lps / (Pump efficiency x102)

Where 102 is the conversion factor for kW.

= (96x 3.33)/ (0.54x102) = 5.8 kW

Power in entire range of head (considering 20% margin) = 7kW

Recommended prime mover rating = 7.5 kW

3.3 A suitable 7.5 kW (10 HP) pump set with 12 stages for the total head of 96 m and discharge rate of 200 lpm is to be selected from the manufacturers catalogue

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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